

This information was prepared by Battelle Memorial Institute, Columbus Operations, through sponsorship by various companies and associations, the South Coast Air Quality Management District (District), and the California Energy Commission (Commission). Battelle has endeavored to produce a high quality study consistent with its contract commitments. However, because of the research and/or experimental nature of this work, the District or Commission, Battelle, the sponsoring companies and associations, along with the employees, contractors, and subcontractors of each of them, make no warranties, expressed or implied, and they assume no legal liability for the information in this report. The District or Commission has not approved or disapproved this report, nor has the District or Commission passed upon the accuracy or adequacy of the information contained herein.

### **Table of Contents**

	Page
Glossary	viii
Introduction .	
Vehicle Inform	nation
Fuel S	System Technologies
Vehicle Maint	enance
	bach
Oil Consumpt	ion and Analysis
1.1	bach
Engine Teardo	own
	53 ts
Discussion	
Oil C	ele Maintenance
Appendix A.	Repair Order Summaries
Appendix B.	Data Analysis Approach B-1
Appendix C.	Average Engine Metal Removal
Appendix D.	Oil Contaminant, Additive, and Property Levels

# Table of Contents (Continued)

Page

#### **List of Tables**

Table 1.	Selected Powertrain and Vehicle Specifications
Table 2a.	Relative Differences in the Number of Non-Accident Repair Orders per 100 Service Days Between Alternative Fuel Vans and Unleaded Gasoline Vans
Table 2b.	Relative Differences in the Number of Selected Repair Orders per 100 Service Days Between Alternative Fuel Vans and Unleaded Gasoline Vans
Table 3.	Vehicle Availability and Utilization
Table 4.	Measured Properties of Unused Oil Samples
Table 5.	Information Available from the Analysis of Used Oil Samples
Table 6.	Summary Information on Oil Change Intervals and Oil Consumption Rates
Table 7a.	Average Cumulative Engine Metal Loss (grams) at 10,000 Miles
Table 7b.	Average Cumulative Engine Metal Loss (grams) at 20,000 Miles
Table 7c.	Statistically Significant Differences Between Engine Metal Accumulations in Alternative Fuel and Unleaded Gasoline Vehicles at 10,000 and 20,000 Miles
Table 8.	Normalized Relative Differences in Total Base Number, Viscosity, and Nitration of Used Oil After 3,000 Miles
Table 9.	Engine Teardown Observation Highlights

## Table of Contents (Continued)

Page **List of Figures** Figure 1. Figure 2. Figure 3a. Non-Preventive Maintenance Summary (All Non-Accident Repairs) Maintenance Costs per 100 Service Days by Location, OEM, Figure 3b. Non-Preventive Maintenance Summary (Selected ATA Codes) Maintenance Costs per 100 Service Days by Location, OEM, Figure 4. Figure 5. Figure 6. Cumulative Weight of Iron Removed from 13 Ford Propane Gas Engines Estimated Total Base Number of Used Oil Versus Number of Miles Figure 7a. Between Oil Changes for Each Combination of Vehicle Manufacturer Figure 7b. Estimated Viscosity of Used Oil Versus Number of Miles Between Oil Changes Figure 7c. Estimated Nitration of Used Oil Versus Number of Miles Between Oil Changes 

#### **Glossary**

ADP = Adaptive digital processor

AFE = Advanced fuel electronic

ARB = Air Resources Board (California)

ATA = American Trucking Associations

CNG = Compressed natural gas

ECU = Electronic control unit

EGR = Exhaust gas recirculation

FFV = Flexible fuel vehicle

Fleet = A unique combination of vehicle manufacturer and type of fuel

GVWR = Gross vehicle weight rating

IAC = Idle air control

LPG = Liquefied petroleum gas

M-85 = Methanol fuel comprised of 85 percent methanol and 15 percent RFG by volume

MAP = Manifold absolute pressure

OEM = Original equipment manufacturer

PM = Preventive maintenance

ppm = Part per million

PRO = Propane gas

RFG = California Phase 2 reformulated gasoline

RO = Repair order

SCE = Southern California Edison

TBN = Total base number

UNL = Unleaded, regular gasoline

VAGIS = Vehicle and Ground Support Equipment Information System

VURR = Vehicle Use and Repair Report